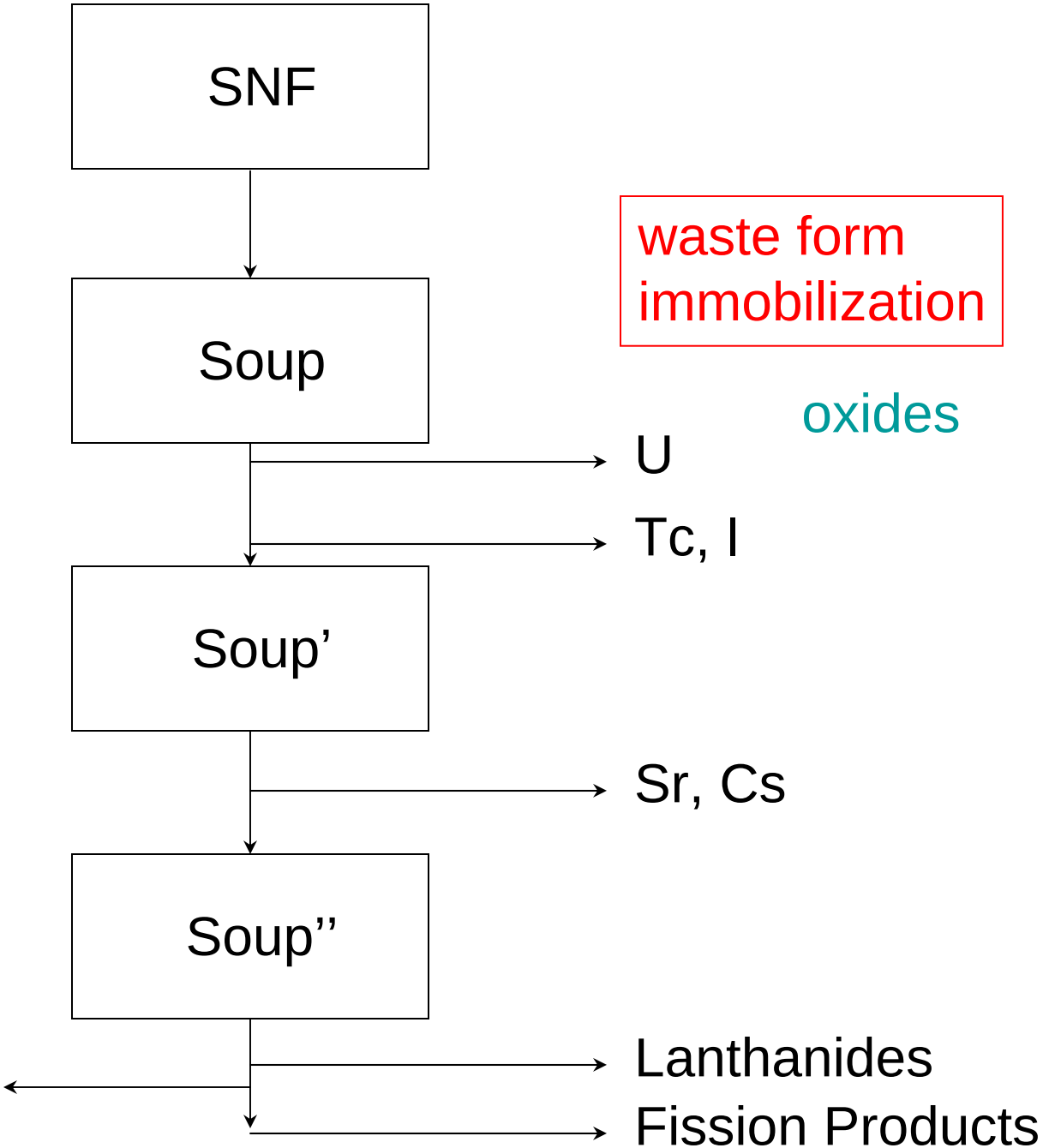
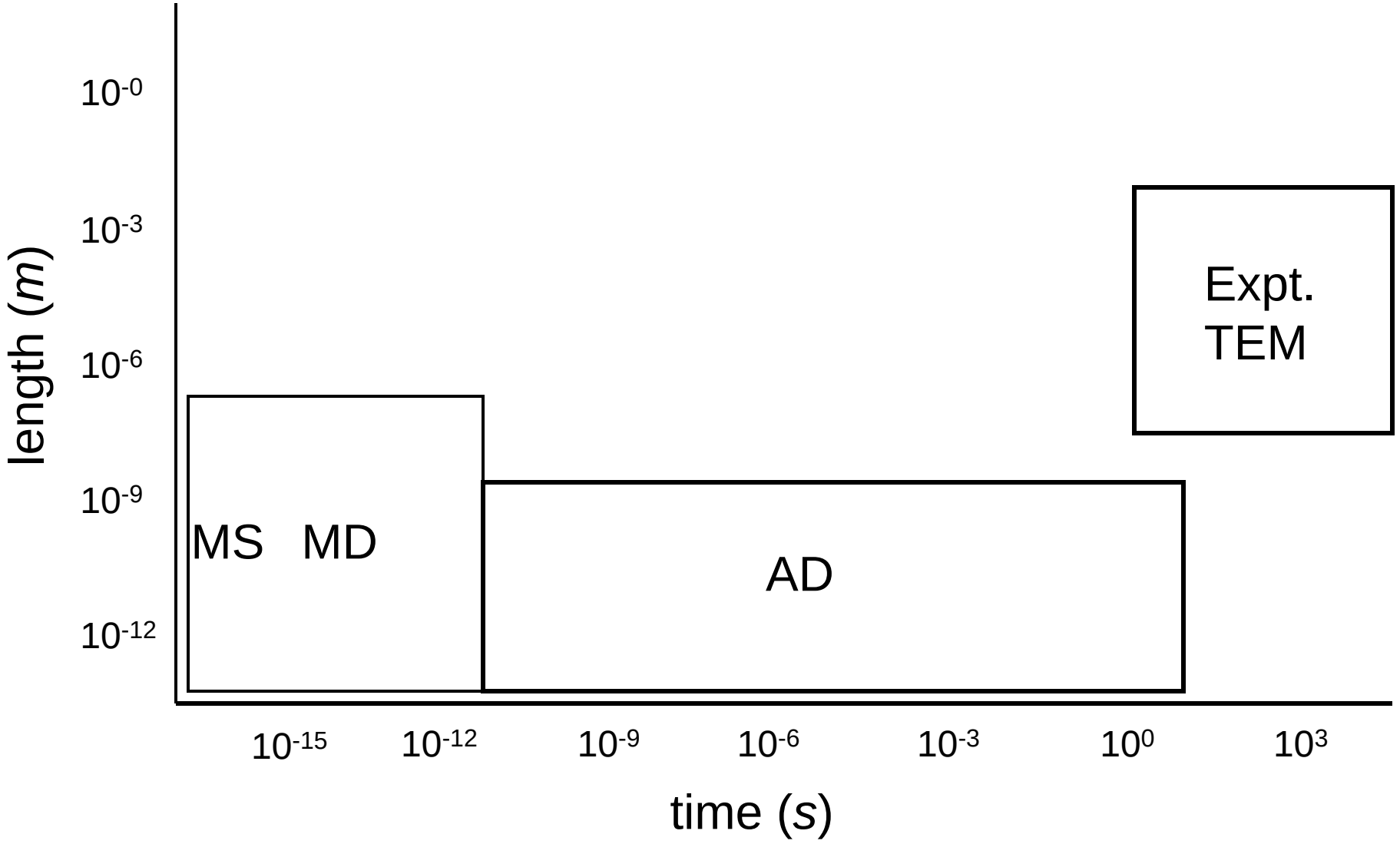
Closed Fuel Cycle Opportunities:

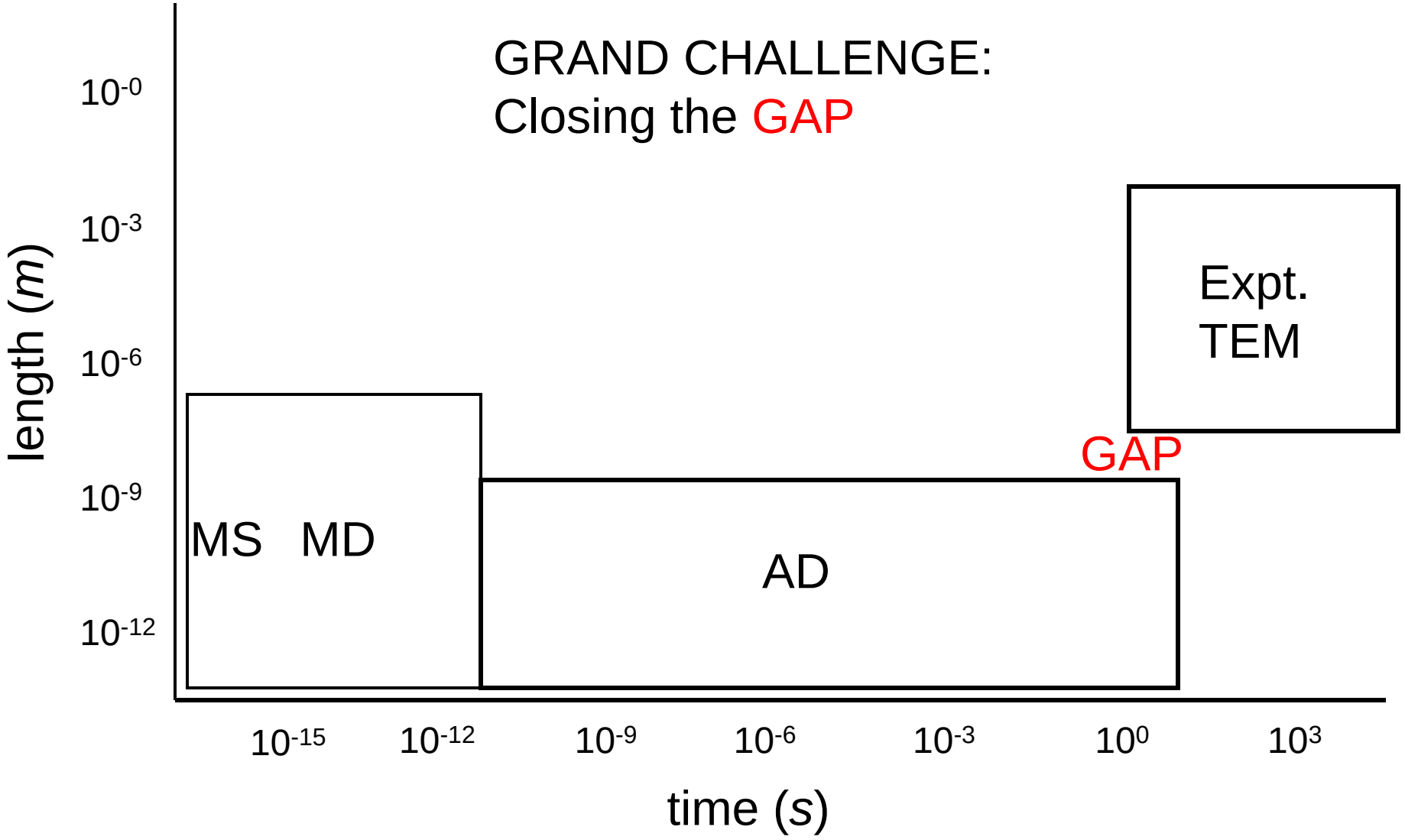
Advanced fuel form & waste form development



Multiscale *Science*



Multiscale *Science*



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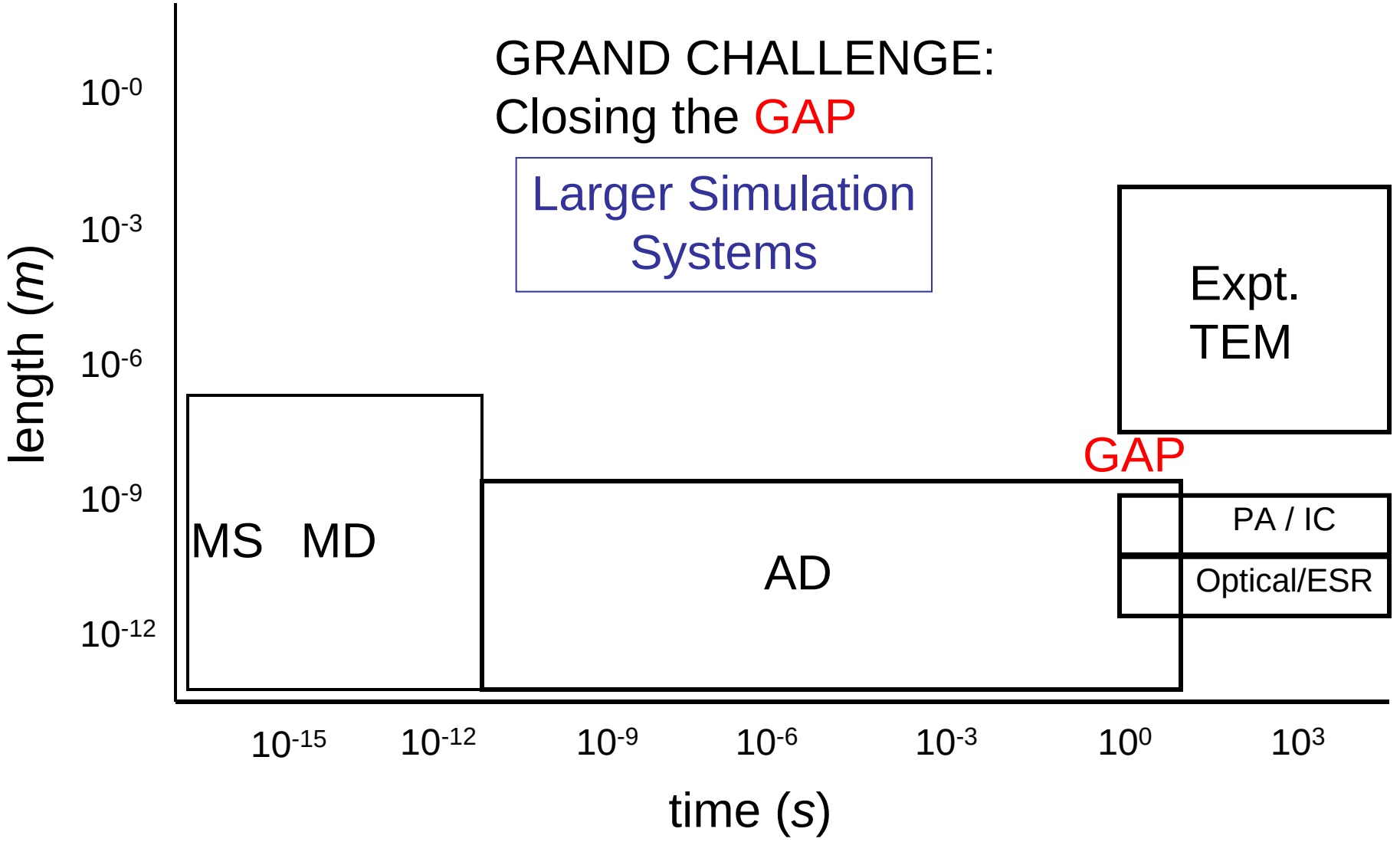
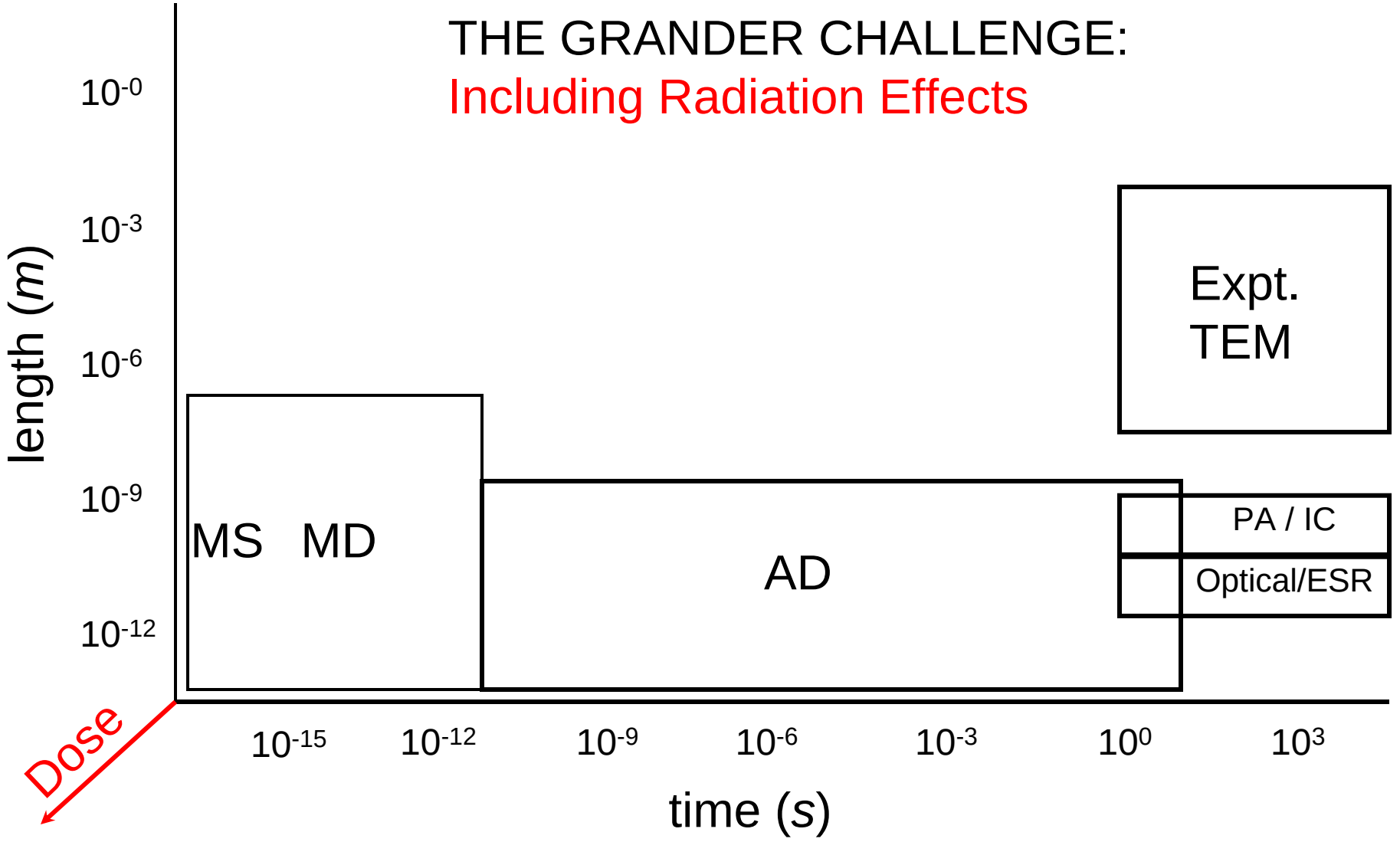
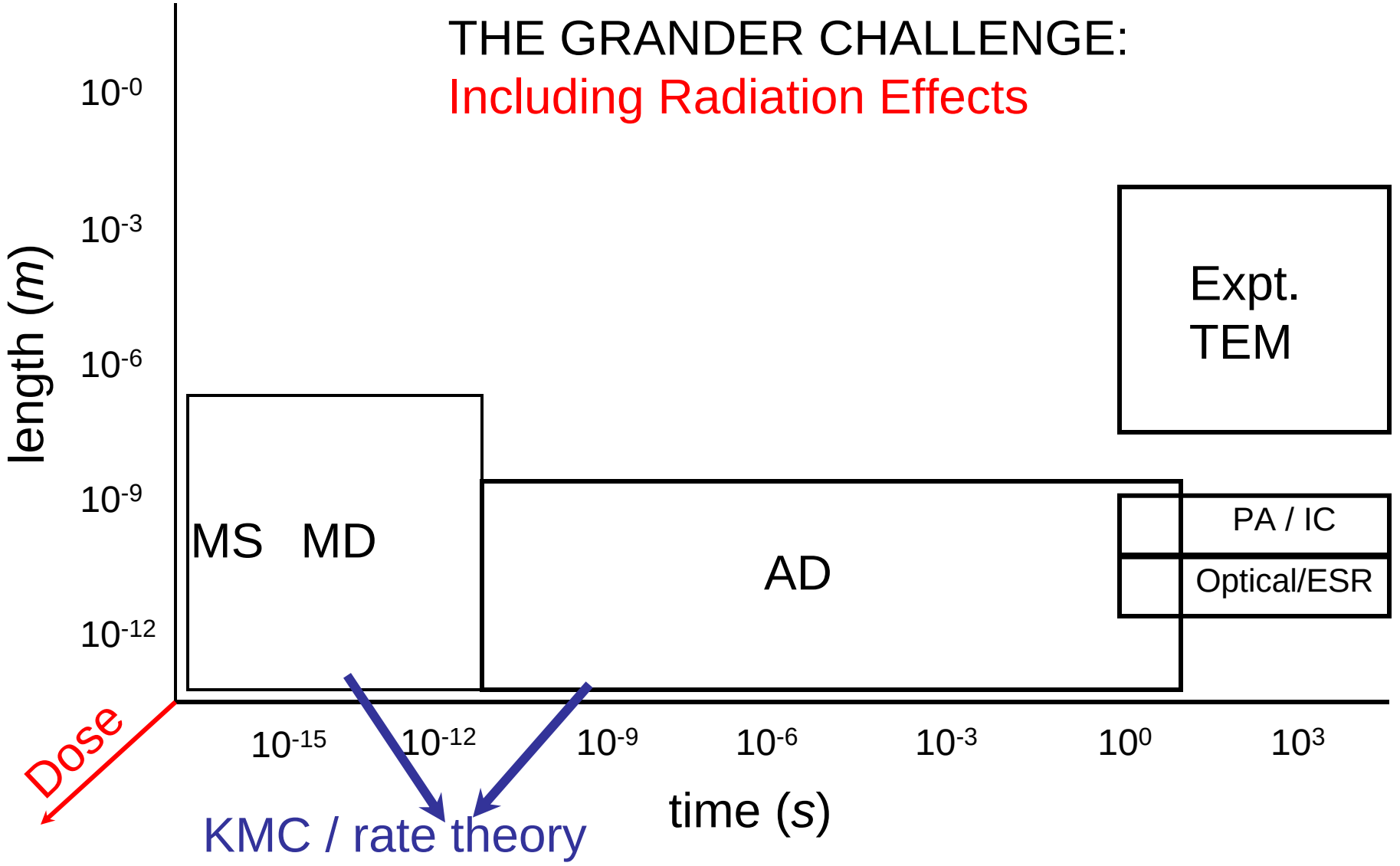


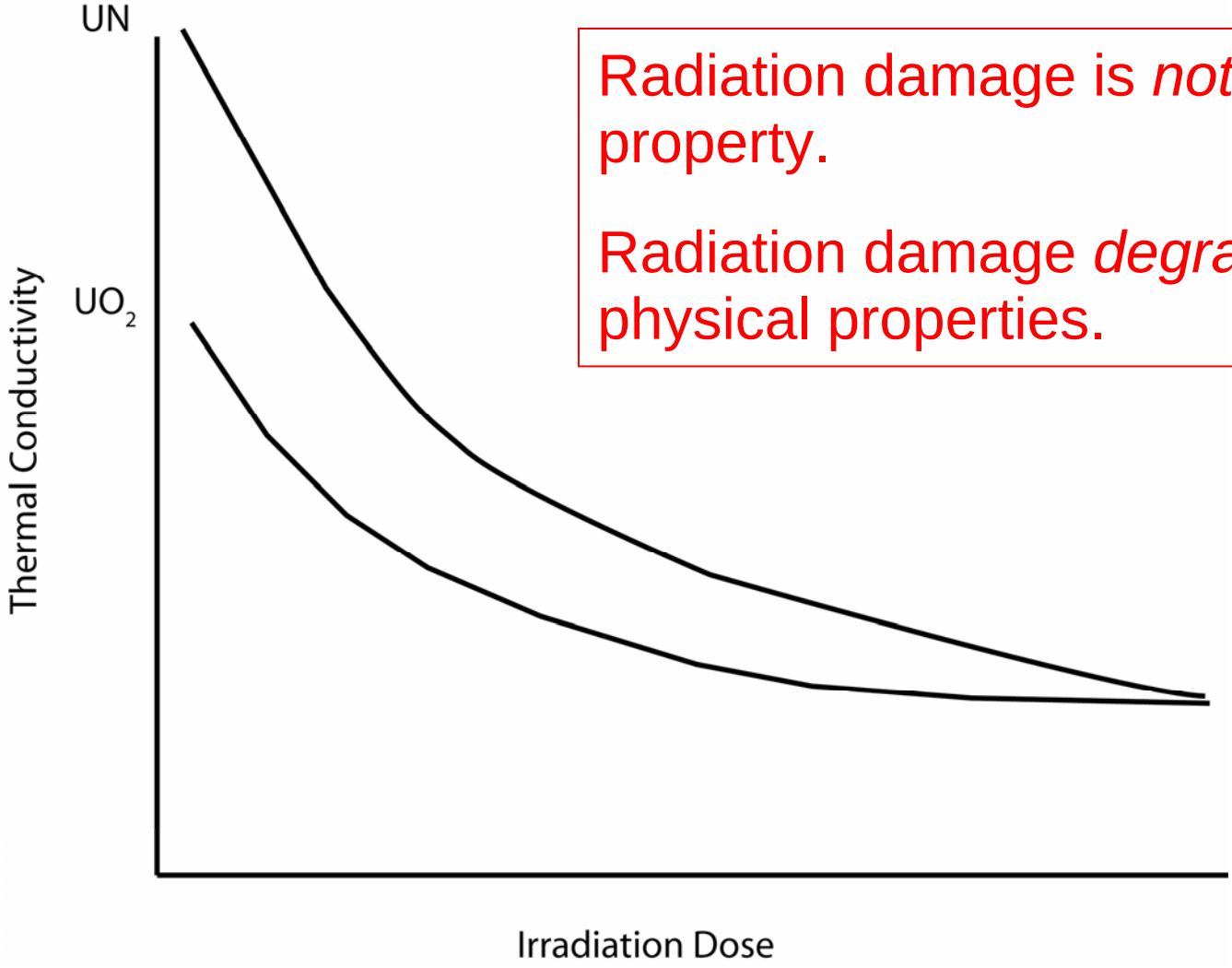
Multiscale *Science*



Multiscale *Science*



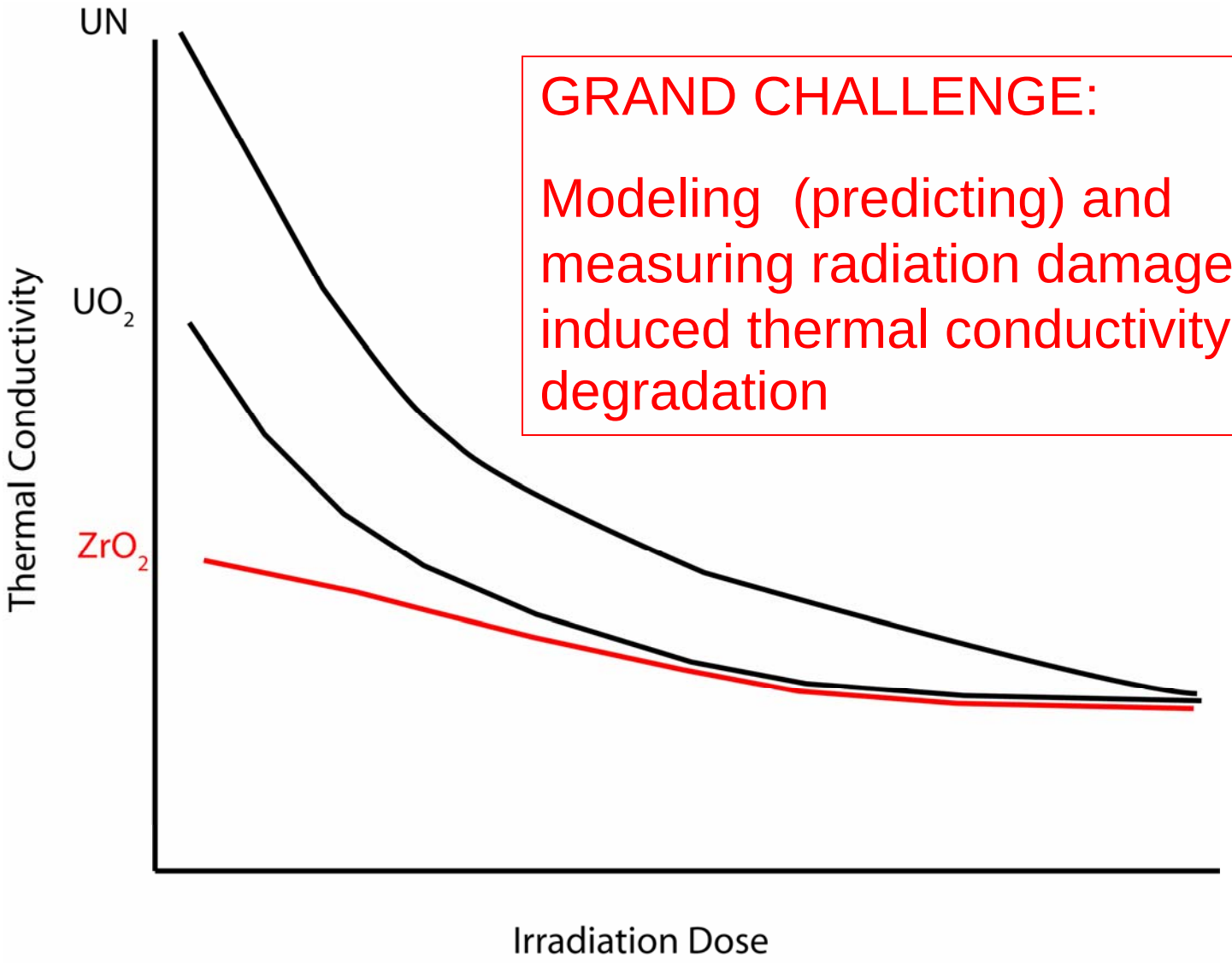
Radiation-Induced Thermal Conductivity Degradation



Radiation damage is *not* a property.

Radiation damage *degrades* physical properties.

Radiation-Induced Thermal Conductivity Degradation



GRAND CHALLENGE:

Modeling (predicting) and measuring radiation damage induced thermal conductivity degradation

Grand Challenge

To predict the performance of various classes of materials in hostile environments and to identify materials with optimum properties for specific applications.

Can we predict *radiation tolerance*?

We need to better understand radiation damage mechanisms.

Key Opportunity

A national, extensive, comprehensive, fundamental program to perform *systematic* investigations of materials' response to hostile irradiation environments. *Systematic* studies are far superior to the current modus operandi, a potpourri of in-pile irradiations, with engineering decisions based on (naïve at best) '*survives/falls apart*' performance criteria.

Key Opportunity: Systematic Investigations

- *Impurities* (effects on atomic mobility, radiation damage response) (FP retention)
- *Stoichiometry* (UO_{2+x}; ZrO_{2-x}) (effects on defect mobility, radiation damage response)
- *Disorder* ($A_xB_yO_z$) (effects on atomic mobility, radiation tolerance)
- *Bonding* (role of ionicity on radiation tolerance; modeling charge transfer)
- *Structure* (radiation tolerance sequence in sesquioxides: ABO_3 perovskites < AAO_3 corundums < ABO_3 ilmenites < AAO_3 bixbyites) Why?